CREOL
The College of Optics and Photonics
University of Central Florida

OSE 3052: Foundations of Photonics

COURSE SYLLABUS

Instructor: Dr. Patrick LiKamWa
Office: CREOL A211
Phone: 407-823-3816
E-Mail: patrick@creol.ucf.edu
Recitation Instructor: Dr. Patrick LiKamWa

Term: Fall 2020
Class Meeting Days: Mondays and Wednesdays
Class Meeting Time: 3:00 PM - 4:15 PM
Class Location: CREOL 102 and ZOOM
Wednesdays: 2:00 PM – 2:50 PM in CREOL A214 and ZOOM

Office Hours: by appointment via ZOOM

I. University Course Catalog Description

Introduction to wave and photon models of light. Interference and Diffraction of light. Polarization. Spectrometer and Interferometers.

II. Course Overview

Introduction:

Some of the main growth areas in the "high-tech" sectors are centered on the branch of optics known as "Photonics", examples are; displays, data storage, telecommunication systems. This is not a temporary phenomenon. Continued growth of optics and photonics based industries means that there will be a growing and permanent need for engineers and scientists with some training in optics. Other areas of optics, such as bio-photonics, laser machining, laser marking, infrared imaging, etc. are growing strongly also. These topics are covered in the other courses in the Photonic Science and Engineering degree program. This course provides students with the strong foundation in optics that will be needed for the subsequent courses. We will frequently make reference to applications as we go.

Content:

This course introduces the basic descriptions of light as waves (physical optics), and photons.
Interference of optical waves is described along with interferometers and their applications to optical metrology and sensing.
Diffraction of optical waves propagating through apertures is examined and the effects on the resolution of imaging systems and the spreading and focusing of optical beams are covered.
Diffraction gratings and grating spectrometers will be studied.
The polarization of light and polarization devices used to control light will be examined.
Regarding light as photons, a brief introduction to absorption, emission, and luminescence phenomena is followed by a brief description of photonic devices such as light emitting diodes, lasers and optical detectors.
The more advanced electromagnetic properties of light are mostly postponed to the next course in the sequence: OSE 3053 Electromagnetic Waves for Photonics.

III. Course Learning Objectives

Upon completion of this course, students should understand the basic principles of modern physical optics and photonics. They should be able to read the specifications of commercial optical instruments such as a scanner for a laser printer, or a spectrometer, and determine how these specifications impact the intended application. They should also be able to solve analysis and design problems for basic optical systems such as the following examples:

- Determine the changes in the Young's double-slit interference pattern that result from bringing the slits closer by some factor.
- Determine the changes in the Michelson interferogram that result from moving one of the mirrors or inserting a thin glass slab in one of the arms.

IV. Course Prerequisites

MAP 2302 Differential Equations or EEL 3470 Electromagnetic Fields.

V. Credits

3

VI. Course Textbook

Optics, 5th ed., Eugene Hecht, Pearson, 2016.

Reference (Optional) Books

Introduction to Optics, 3rd ed., F. L. Pedrotti, L.S. Pedrotti and L. M. Pedrotti, Prentice-Hall, 2009

Schaum's Outline of Theory and Problems of Optics, Eugene Hecht, McGraw Hill, 1975.

Fundamentals of Photonics, 2nd edition B. Saleh and M. Teich, Wiley, 2007

VII. Course Requirements

- The student is expected to review the textbook, notes, and other materials before class. Occasionally you may be required to a take short quiz at the beginning of class.
- You are required to attend class as well as the mandatory discussion sessions

VIII. Course Grading

Grading Scale (%)	Rubric Description
$100 \geq A > 93 \geq A^{-} > 90$	Excellent, has a strong understanding of all concepts and is able to apply the concepts in all and novel situations. Has full mastery of the content of the course.
$90 \geq B^{+} > 87 \geq B > 83 \geq B^{-}$	Good, has a strong understanding of most or all of the concepts and is able to apply them to stated and defined situations.
$80 \geq C^{+} > 77 \geq C > 73 \geq C^{-}$	Average, has a basic understanding of the major concepts of the course and is able to apply to basic situations.
$70 \geq D^{+} > 67 \geq D > 63 \geq D^{-}$	Below average, has a basic understanding of only the simple concepts and is able to apply to only a limited number of the most basic situations.
$60 \geq F$	Demonstrates little to no understanding of the course content.

Course Item	Percent of Final Grade
Homework	10%
Quizzes	20%
Two mid-term tests (20% each)	40%
Final Exam	30%
	100%

IX. Grading Objections

All objections to grades should be made IN WRITING WITHIN ONE WEEK of the work in question. Objections made after this period has elapsed will NOT be considered – NO EXCEPTIONS.

X. Professionalism and Ethics

Academic dishonesty in any form will not be tolerated. If you are uncertain as to what constitutes academic dishonesty, please consult The Golden Rule, the University of Central Florida's Student Handbook (http://www.goldenrule.sdes.ucf.edu/) for further details. As in all University courses, The Golden Rule Rules of Conduct will be applied. Violations of these rules will result in a record of the infraction being placed in your file and the student receiving a zero on the work in question AT A MINIMUM. At the instructor's discretion, you may also receive a failing grade for the course. Confirmation of such incidents can also result in expulsion from the University.

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XI. Students with Special Testing/Learning Needs

Students with special needs and require special accommodations must be registered with UCF Student Disability Services prior to receiving those accommodations. Students must have documented disabilities requiring the special accommodations and must meet with the instructor to discuss the special needs as early as possible in the first week of classes. UCF Student Disability Services can be contacted at http://www.sds.sdes.ucf.edu/, or at (407) 823-2371.

XII. Excusal from Course Assignments and Course Examinations

If an emergency arises and a student cannot submit assigned work on or before the scheduled due date or cannot take an exam on the scheduled date, the student MUST give notification to the instructor NO LESS THAN 24 HOURS BEFORE the scheduled date and NO MORE THAN 48 HOURS AFTER the scheduled date.

XIII. Class Attendance and Participation

- Regular class attendance is expected either in person or via ZOOM.
- Come to class prepared.

Note: The instructor reserves the right to modify the information contained in this document at his discretion.

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OSE 3052: Introduction to Photonics

COURSE SCHEDULE

1	Introduction and Course Overview		General Memo - High level talk about how Photonics is everywhere around us
2	Wave Motion	Ch-2	Basic harmonic waves - The differential wave equation - Simple Harmonic Waves - Phase and Phase Velocity - Superposition Principle - The Complex Representation - Phasors and the Addition of Waves - Plane waves -The 3-D Differential Wave Equation - Spherical Waves
3	Photons and Light	Ch-3	Photons as a wave packet - The Wave-Particle Duality - DeBroglie's Principle - The energy of the photon through Einstein relation E = hf - Concept of photon flux and optical power - How for small optical powers the large number of photon/s leads to continuous waves - Single and few photons concepts in imaging - Initial concepts of discrete atomic energy for photon emission.
4	The Superposition of Waves	Ch-7	Addition of coherent waves - Algebraic, Complex and Phasor Additions - Superposition of Waves with different frequencies - Group Velocity and Dispersion - Fourier Series
5	Polarization	Ch-8	Linear Polarization - Malus Law - Polarization by Reflection (Brewster Law)
6	Interference	Ch-9	Temporal and Spatial Coherence - Fresnel-Arago Laws - Young's Experiment - Fresnel's Double Mirror and Lloyd's Mirror - Thin Film Interference - Fizeau Interferometer - Michelson Interferometer - Mach-Zehnder Interferometer - Sagnac Interferometer - Fabry-Perot Interferometer - Single Layer Anti-reflection Coating
7	Diffraction	Ch-10	Fraunhofer vs Fresnel Diffraction - The Single Slit - The Double Slit - Diffraction by Many Slits - Rectangular Aperture - Circular Aperture - Airy Disk - Diffraction Grating - Spectral Resolving Power

Note: The dates of the topics will be posted on Webcourses and are subject to change depending upon how things progress during the course of the semester

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University-Wide Face Covering Policy for Common Spaces and Face-to-Face Classes
To protect members of our community, everyone is required to wear a facial covering inside all common spaces including classrooms (https://policies.ucf.edu/documents/PolicyEmergencyCOVIDReturnPolicy.pdf. Students who choose not to wear facial coverings will be asked to leave the classroom by the instructor. If they refuse to leave the classroom or put on a facial covering, they may be considered disruptive (please see the Golden Rule for student behavior expectations). Faculty have the right to cancel class if the safety and well-being of class members are in jeopardy. Students will be responsible for the material that would have been covered in class as provided by the instructor.

Notifications in Case of Changes to Course Modality
Depending on the course of the pandemic during the semester, the university may make changes to the way classes are offered. If that happens, please look for announcements or messages in Webcourses@UCF or Knights email about changes specific to this course.

COVID-19 and Illness Notification
Students who believe they may have a COVID-19 diagnosis should contact UCF Student Health Services (407-823-2509) so proper contact tracing procedures can take place.
Students should not come to campus if they are ill, are experiencing any symptoms of COVID-19, have tested positive for COVID, or if anyone living in their residence has tested positive or is sick with COVID-19 symptoms. CDC guidance for COVID-19 symptoms is located here: (https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html)
Students should contact their instructor(s) as soon as possible if they miss class for any illness reason to discuss reasonable adjustments that might need to be made. When possible, students should contact their instructor(s) before missing class.

In Case of Faculty Illness
If the instructor falls ill during the semester, there may be changes to this course, including having a backup instructor take over the course. Please look for announcements or mail in Webcourses@UCF or Knights email for any alterations to this course.

Course Accessibility and Disability COVID-19 Supplemental Statement
Accommodations may need to be added or adjusted should this course shift from an on-campus to a remote format. Students with disabilities should speak with their instructor and should contact sas@ucf.edu to discuss specific accommodations for this or other courses.

Statement for Courses with a Face-to-Face Component

Should this course shift to remote-only instruction, the university has provided several resources to assist students with learning: https://digitallearning.ucf.edu/newsroom/keeplearning/

Live and Recorded Lectures (optional if applicable): This course will include synchronous ("real time") sessions that will also be available as a recorded session for later review in Webcourses@UCF. Students who are unable to attend on-campus sessions, are expected to review these available sessions. Students who are unable to actively participate in on-campus or remote learning, should contact their instructor to explore options. Any synchronous meeting times will be announced via Webcourses@UCF and should appear on the Webcourses@UCF calendar should remote instruction be activated.
Such recordings/streaming will only be available to students registered for this class. These recordings are the intellectual property of the faculty and they may not be shared or reproduced without the explicit, written consent of the faculty member. Further, students may not share these sessions with those not in the class or upload them to any other online environment. Doing so would be a breach of the Code of Student Conduct, and, in some cases, a violation of the Federal Education Rights and Privacy Act (FERPA).

Technology Access – Depending upon modality, this course might need to shift to remote or fully online instruction based on medical guidance. This course also could be fully online and thus this could require access to additional technology. If students do not have proper access to technology, including a computer and reliable Wi-Fi, please let the instructor know as soon as possible. Information about technology lending can be found at https://it.ucf.edu/techcommons/ and https://library.ucf.edu/libtech.